AN OVERVIEW OF THE RECONSTRUCTION PROGRAM AFTER THE EARTHQUAKE OF BAM, IRAN

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Abstract

This paper reviews the approach that authorities have employed for the post-earthquake reconstruction of Bam, Iran, and highlights the importance of combining new construction technologies with local know-how to improve the sustainability of such projects. The conclusions of this paper are based on the information gathered through fieldwork and observations gathered in the city of Bam after the earthquake as well as a review of the literature concerning this earthquake. In addition, this research studies the problems and failures that the reconstruction program in Bam has in common with similar cases around the world.

The paper consists of two main parts. In part one, the pre-earthquake building practices in Bam are studied to arrive at the conclusion that the failures of the buildings in the earthquake were neither the result of a lack of construction technology, nor the consequence of a shortage of building materials but were the result of poor workmanship and lack of construction knowledge. In part two, the reconstruction efforts underway in Bam are reviewed briefly to illustrate the general idea of the program, followed by a critical look at the top-down, imported technology-based approach of the program.

Keywords: Reconstruction; earthquake; Bam; top-down (technology-based) approach; construction know-how; balanced program.

PART ONE: BUILDING PRACTICES IN BAM BEFORE THE EARTHQUAKE

A 6.7 magnitude earthquake severely damaged the city of Bam, Iran on December 26th 2003. According to the International Federation of Red Cross and Red Crescent Societies (2004) approximately 45,000 people died, and more than 75,000 residents were left homeless. The majority of houses in Bam were built out of adobe and raw soil, and the vast destruction throughout the city was first thought to be the result of these supposedly poor construction materials. A closer look at what remained of the city, however, reveals that this is not the whole story. It is now known from the evidence in the ruins, that poor workmanship and

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lack of construction know-how were the main causes of the devastation, regardless of whether the buildings were made of earth, concrete or steel.

In the following paper, the flaws and mistakes of the construction practices that resulted in the destruction of buildings in Bam are studied based on the fieldwork conducted in February 2005, as well as information and pertinent literature gathered from respected authorities. Although some of the destroyed buildings were still in the condition as they were after the quake, the majority of damaged buildings were bulldozed at the time of visit, some 14 months after the earthquake. Luckily, there were quite a lot of pictures taken by others in the weeks following the earthquake. These were the main source of study in this part. The different types of buildings in the city and their devastation in the earthquake will be studied by focusing on two main problems: 1) design and construction knowledge; and 2) implementation. The report aims to uncover major problems existing in the construction practices in Bam. As a result, the current reconstruction situation in Bam will also be studied. The methodology is based on an analysis of pictures taken of buildings destroyed in the earthquake in tandem with a study of the literature published concerning the earthquake in Bam.

Design/Know-how

The term *design* here refers to any sort of formal or informal knowledge of construction applied to the building by the builder. In other words, the *design* does not only address the technical and engineering aspects of construction; rather, the formal and popular knowledge employed comprises the *design* of a building. This section examines certain design failures that resulted in the destruction of certain buildings in Bam and is divided into two general categories: 1) structural components, and 2) implementation. Each of these is then divided into several subsections.

Structural components

Foundation

The foundation anchors the whole building to the ground, reducing the movement of the building during earthquakes. The lack of a good and appropriate foundation is a common problem among the buildings destroyed in Bam, and a number of houses did not have any sort of foundation at all.

Walls

As walls were analyzed after the earthquake in Bam it was revealed that none of the walls were reinforced. The reinforcement of load-bearing walls is not a common practice in Bam, and even simple measures such as placing vertical and/or horizontal reinforcement bars are non-existent. Furthermore, some of the load-bearing walls were not thick enough to resist the bending and the shear force caused by earthquakes. Even in the cases where the walls seemed to have the appropriate thickness, the length of the wall and/or its height weakened its resistance to lateral forces. Moreover, the inappropriate placement of openings (i.e. windows and doors) and/or their proportions to the overall wall area greatly reduced the strength of the wall.

Columns, Beams, Bracings

The majority of post-and-beam buildings in Bam were built without adequate attention to engineering principles. For the most part, local masons or even the owners themselves were the builders, many of whom lacked knowledge about effective construction techniques. Their knowledge still remains very limited in this area because post-and-beam construction is relatively new in Bam. The people of Bam in the past, however, were quite knowledgeable in the type of construction used for over two thousands years, which includes wall systems composed of load-bearing earth walls, barrel vaults, and cupolas.

Weak steel columns and beams, and a lack of cross-bracings are the dominant mistakes in the cases of steel-frame buildings destroyed in Bam. Concrete buildings had problems with the inadequate number and/or size of reinforcement steel bars. In one case, surprisingly, the steel bars of the beam were eliminated. This lack of knowledge about concrete construction is a serious problem generally in Iran, but in smaller cities, it is much more critical.

Roofs / Floors

Roofs and floors play an important role in the resistance of a building towards earthquakes because they constitute the main load of the building. Logically, the lighter a roof is, the less of a risk that the structure will collapse during an earthquake. This situation affected a majority of homes in Bam, which had very heavy roofs. Moreover, a number of houses were overloaded from the addition of new stories on top of the existing houses. These extensions, built on structures without properly engineered load-bearing walls, led to the destruction of many buildings and the loss of entire families (Maheri, 2004).

Building Plan

A building plan must always account for potential lateral forces that occur during earthquakes and include a design element to *resist* these forces. In order for a building to gain more resistance in earthquakes, it is useful to follow two general rules: first, the plan should be as simple and compact as possible, and second, complex shapes must be avoided. These two essential considerations were ignored during the planning phase of a number of the recently built homes that were consequently destroyed.

Implementation

No matter how well designed a building is, it will collapse in an earthquake if proper care is not taken in the construction process. A lack of construction knowledge among a majority of the laborers and masons, along with inadequate building inspection made many buildings in Bam vulnerable to the earthquake.

Moreover, the lack of decent yet affordable construction materials made the situation even worse, since the majority of Bam's citizens are poor or lower middle-class. It is thus hard for them to afford quality materials that are imported from other parts of the country.

By and large, the problem with the implementation can be divided into two general categories: first, problems arising because of improper or poor construction materials, and second, problems arising from poor workmanship and construction details.

Building Materials

Needless to say, the quality of construction materials has an indisputable effect on the resistance and strength of a building to exerted forces. Buildings in Bam range from traditional earth buildings to those made of concrete and steel. Due to the poor quality of construction materials employed, severe destruction can be seen amongst all types of buildings, regardless of the building material. In the following, the buildings destroyed in Bam are studied in terms of the quality of their construction materials, categorized into four groups: 1) earthen, 2) steel frame, 3) concrete, and 4) hybrid buildings.

Earth Buildings

Building with earth has a long history in Bam, dating back some 2500 years, when the city was founded. This traditional mode of construction is common throughout Bam, a city well known for its glorious, magnificent earth architecture, where one of the biggest earthen complexes in the world existed, the Bam Citadel. Although the citadel was destroyed in the earthquake, its survival for such a long period of time indicates the strength and durability of earthen materials. A number of these buildings remained intact, proving that the use of appropriate materials, along with adequate maintenance in the case of old buildings, would help earthen buildings withstand severe earthquakes.

Since the soil used for making earthen buildings is naturally diverse in its contents, and since each type of soil suits a specific construction technique, great care must be taken in choosing appropriate soil for each construction method. For example, if one wants to build with adobe, the soil contents must be suitable for making adobe bricks. Otherwise, the strength of the building would decrease remarkably. The poor resistance of the many earth buildings in Bam was due in part to the inappropriate soil content for various earthen architectural techniques.

Steel Frame Buildings

The problem of materials in steel frame buildings in Bam refers primarily to the incompatibility of masonry materials used as wall infill and/or roofs. Masonry construction materials in Bam, which are mainly burnt brick and sand-cement mortar, fit together with a fairly good cohesion if skillfully executed. Nonetheless, the adhesive agent (i.e. cement in the case of sand-cement mortar) does not bond well with steel, and is often incapable of providing holistic cohesion in the building. The problem shows up in walls where the wall directly meets a column or beam, and in roofs composed of steel beams with jack arches in between, though the mortar is soil-and-chalk in this case.

In both cases, a lateral force like an earthquake tremor could easily make the walls or jack arches spring apart from the steel frames, leaving the brick mass detached from the structure, causing it to collapse. A lot of houses were observed in Bam where the body collapsed while the skeleton of the frame (i.e. posts and beams) remained standing.

Concrete Buildings

Construction with concrete is a relatively new practice in Bam. As a result, Bam is just now gaining knowledge about how to produce good quality reinforced concrete and how to build effective structures. Generally speaking, the performance of a concrete structure depends on the proper mix of ingredients as well as efficient reinforcement. Ignoring these essential factors and overlooking the importance of careful inspection in the production of concrete resulted in the destruction of the majority of concrete buildings in Bam, many of which were built very recently.

The defects of concrete structures in Bam mainly were rooted in the high price of materials necessary for quality concrete buildings, including cement, infill ingredients, and steel reinforcement bars. The price of cement for the average citizen is relatively high, because cement must be imported from other parts of the country, which impose shipping and handling costs. Quite understandably, from the point of view of a non-educated builder or owner, the increase in costs would likely lead to a reduction of the percentage of cement and/or steel in the concrete mix, in order to maintain the total cost estimates. In addition, the lack of construction know-how with concrete among local builders and masons resulted in the use of unsuitable concrete filler: ingredients such as construction waste and debris, which ultimately reduce the strength of the structure.

Moreover, the high price of steel bars, imported from remote parts of the country, intensified the problem. Many builders and owners reduced the steel bar reinforcements in size (diameter), quantity, and quality, while increasing the distance between stirrups for the sake of minimizing costs.

Hybrid Buildings

The term *hybrid* here refers to buildings employing two or more different structural systems. For example, a number of buildings in Bam were built using steel columns together with flat concrete span roofs, reinforced concrete columns with steel beams/girders, or load bearing earth walls with steel girders resting on the wall, and so forth. The combination of different structural systems, using various materials and methods was often the consequence of efforts to reduce the cost of building. Owners often looked for the cheapest materials and methods that are simple enough to be executed by ordinary laborers as opposed to sophisticated methods that need skilled masons commanding higher wages.

Generally, the major problem with hybrid buildings is the inconsistency of different building materials and designs unsuitably mixed together in one structure. When an external lateral force, such as an earthquake, is exerted on the different parts of the structure they do not behave in the same way and react differently, intensifying the destruction rate and reducing the resistance capacity of the building.

Moreover, the difference between materials of the walls and roofs in wall-bearing structures, common in many kinds of hybrid buildings in Bam, requires relatively sophisticated methods at the joints where the two systems meet. If improperly joined, these conjunctions are often the starting points of a collapse. In addition, it is very common in Bam, and in many other cities in Iran, to reuse construction materials, especially bricks, remaining from demolished buildings in the construction of new ones. The problem is that used bricks often bond poorly with mortar, and the walls made of such bricks cannot withstand earthquakes.

Workmanship and Details

One of the most important stages of any construction process that directly affects the strength of the building is the actual implementation of the construction. It can be said that the most serious problem with buildings in Bam is the result of the poor quality of construction details. In other words, it seems that builders and masons in Bam, especially those who build with new construction materials such as concrete and steel, either do not pay any attention to the execution and workmanship during the construction, or simply do not have appropriate knowledge of construction and detailing. The latter is most likely the case in the majority of houses in Bam since a great percentage of houses, if not all, were built by local masons, the majority of whom have no education in modern construction materials, neither formally nor informally.

When new construction materials were introduced to the locals, masons and builders tried to adapt these new materials to their traditional construction methods. The result was a variety of construction methods that were rarely designed appropriately, and never implemented correctly. In the following, the defects and mistakes are discussed in two categories: first, poor workmanship, and second, weak joints.

Poor Workmanship

No matter what the construction method, almost all of the destroyed buildings in Bam somehow suffered from poor workmanship, which means the ignorance of some simple yet essential considerations by laborers/masons during the construction of the building. For instance, much of the masonry in the city, usually adobe or burnt bricks, received great damage because of inappropriate or awkward bricklaying.

Although Bam has achieved fame for its adobe buildings and earthen structures, the knowledge of bricklaying has seemingly been forgotten among local masons over the last few decades. For example, even the simple though important practice of soaking dry bricks in water before laying them was ignored in the construction of many buildings in Bam. Serious problems occur when dry bricks suck the water from the sand-cement mortar, which needs adequate moisture to be cured and make a good bond.

Another dominant failure in the workmanship is the amateurish work in almost all aspects of steel frame buildings; often, the welding is inadequate and too weak to hold together during earthquakes. Joints are one of the most critical points of the structure and very little attention has been paid to them in the majority of steel-frame buildings in Bam. The lack of gusset plates, stiffener plates, and reinforcing plates were are very common problems of such structures in Bam; these problems are intensified by the poor quality of welding in the joints and anywhere else that reinforcement plates are placed (Hosseini Hashemi, 2004).

Poor workmanship in concrete buildings is also common, though not many concrete buildings have been built in Bam. First of all, the quality of concrete is far below the acceptable standard because it is very often mixed on-site by unskilled labourers, and consequently, the quality varies from time to time. Moreover, due to the lack of concrete construction know-how, there is a misconception that any crushed construction material can be used as an ingredient in the concrete mix. So, it is easy to find concrete columns and beams, most of which were destroyed in the earthquake, with crushed/broken bricks as ingredients. This lack of knowledge extends to the point where builders mistakenly reduce the quantity of steel needed by increasing the distance between stirrups, reducing the girth and number of reinforcements, or even eliminating steel bars from the beam.

Weak Joints

Some points of buildings are more vulnerable to earthquakes due to the diversity of forces exerted on them. Thus, a thorough construction system should reinforce these critical points. It must be emphasized that all structural joints are critical locations, including wall intersections, corners, roof-wall joints and the joints between foundations and walls. These vulnerable points need more attention and close inspection during the construction process. As is the case of majority of buildings in Bam, ignorance of the important role these critical joints play in the resistance of buildings to seismic forces resulted in fragile buildings. This problem can be seen in all types of construction methods in Bam, including earthen, steel-frame, and concrete buildings.

PART TWO: THE RECONSTRUCTION EFFORT

After the earthquake, the reconstruction program became the main concern of the government and local authorities. Soon after, the Housing Foundation of

Islamic Revolution (HFIR) was assigned to take all the reconstruction efforts of Bam under its control. HFIR is a publicly funded, yet non-governmental, organization ruled by a principal designated by the Supreme Leader of Iran. All the activities with regard to the reconstruction of Bam must be accepted by HFIR from the first stages. This situation, considering the fact that many of the initial steps should be taken by the municipality of Bam, has made the process of the reconstruction time-consuming because of the numerous bureaucratic steps citizens face. Not surprisingly, as a result, not many houses had been rebuilt by the time of my visit, some 15 months after the earthquake, though quite a few reconstruction projects had been initiated. Consequently, people who lost their homes in the earthquake were still living in containers or other sorts of temporary accommodations; some even lived in first-aid tents.

In order to take part in the reconstruction of the city, a number of construction factories, building contractors, and architectural consultants have either moved to Bam or established a representative office; the majority of these offices are housed in a complex building provided by HFIR at the periphery of the city. This building is the main core of the reconstruction engineering and architectural enterprise. Beside this HFIR has designated an extensive lot for construction companies and architectural firms to build samples of their proposed buildings, to demonstrate their proposed construction methods to the locals. Each building offers earthquake-resistant features, according to the promoters, who try to convince the citizens to use their specific techniques in the reconstruction of their house. In the following section, all the construction techniques proposed by HFIR and various building companies are briefly reviewed in order to illustrate the general reconstruction concepts designated for Bam.

Housing Foundation of Islamic Revolution (HFIR)

A comparatively small house of 9x9 m^2 has been designated by HFIR engineers and architects as the standard size of a house for an average-sized family in Bam. All the construction companies and architects are thus advised to design and build within these fixed dimensions. In addition, HFIR has designed a pre-fabricated steel-frame structure that fits the 9x9 m^2 house. HFIR recommends that all use this structure in the new buildings that are to be built in Bam.

The structure proposed by HFIR consists of prefabricated steel posts, beams, and bracings that are designed in a way that can easily and quickly be assembled, using only bolts and nuts for fastening the elements together. For example, the structure of a regular house (9x9 m^2, as HFIR recommends) can be installed in place in just few hours, employing only two labourers. Aside from the quick installation, the idea is that using labourers to only fasten the bolts would remarkably reduce the number of failures caused by inadequate welding (Figure 1).

HFIR has built an educational sample of the proposed structure on the exhibition site, where citizens can visit and learn about essential construction details. The whole structure is placed on a reinforced concrete foundation, to which the frame is connected using bolts and nuts (Figure 2). The roofing system and wall infill technique remain flexible to the constructor/owner's decision. HFIR, however, is building a number of publicly funded buildings, using ordinary bricks and/or hollow blocks as wall infill, and a reinforced concrete slab roofing system.

Figure 1: The structure proposed by HFIR

Figure 2: Detail of the HFIR's structure; posts and beams are connected by bolts and nuts

To strengthen the bond between bricks and steel columns and prevent bursting corners during earthquakes, either L-shaped steel bars are used to reinforce corner joints, or the columns are wrapped with chicken wire to enhance the bond with the sand-cement mortar. The roofing system proposed by HFIR consists of prefabricated I-steel beams as girders, which hold a 7-10 cm concrete slab moulded on corrugated galvanized steel sheets as left-in-place moulds. Small Z-shaped steel laths are welded to the girders, connecting the concrete slab to the girders every 50 centimetres. HFIR has built a sample house with its recommended techniques at the demonstration site. The house employs the HFIR prefabricated steel structure, hollow blocks are used as wall infill and the roof is concrete slab. This construction method may change, however, when citizens or other builders in the city begin to make decisions concerning their building. For instance, the wall infill may change from double-side-meshed polystyrene sandwich panels to ordinary burnt bricks or hollow blocks. The roofing system also may vary from thin concrete slabs on steel girders to block-joist system.

Other Construction Companies/Practitioners
All the construction methods offered by building practitioners other than HFIR fall into one of the following categories:

a) HFIR's structure, different components:
The construction method employed by this group consists of the steel frame structure that HFIR has recommended but with different building components such as different roofing or wall infill systems. For instance, some building companies offer drywall and steel stud system for walls and/or pre-stressed concrete slabs for roofing the HFIR's steel frame structure.

b) Prefab structure and components:
Some construction companies offer prefabricated structures such as sandwich panels, prefab trusses, or cold-formed joists and studs as the structure of their proposed building method. Prefabricated components such as drywall panels and/or precast concrete roofs are usually the complementary parts of these systems.

c) Conventional steel-frame structure and lightweight materials:
This group consists of techniques that employ a conventional steel-frame structure, using welding to join the structural components (i.e. posts and beams) together. However, in order to gain better resistance against earthquakes, these models use lightweight materials for roofs and walls, such as sandwich panels and corrugated steel sheets.
d) Reinforced masonry:
There are two foreign institutes; Auroville (India) and Peace-Winds (Japan), who have proposed masonry-based construction techniques. In these methods there

are three essential elements responsible for consolidating the building, thereby increasing its resistance to earthquakes. These three components are horizontal reinforcement elements (ring beams), vertical reinforcements (steel bars), and buttresses alongside the openings. Horizontal reinforcements consist of reinforced concrete beams placed around the building wherever the load-bearing walls are located, usually at four levels: plinth, sill, lintel, and roof height. Vertical reinforcements are steel bars placed within the walls, and must go from the foundation to the upper ring beam at the roof level.

Among the aforementioned institutes, Peace-Winds has taught its proposed method to four local masons during the implementation of the first two buildings in order to disseminate the knowledge of such reinforcing method among the locals.

Advantages and Disadvantages of Proposed Techniques

Two factors – quick and easy installation, and resistance to earthquakes – are the main elements of the idea behind the HFIR structural system, which well addresses these concerns. The construction cost, however, remains a major obstacle. In addition to the high price of the prefabricated steel components that are imported from long distances, some parts of the structure are over-designed, which wastes money and materials. For instance, the X and V bracings employed are unnecessarily thick. The 9x9 cm^2 hollow-section steel bars employed for these bracings can be simply replaced with tiny steel rods or cables, or even a well-done brick wall can do the job. A rough estimation indicates that these bracings constitute around 30 percent of the total steel used in the proposed structure. Moreover, earthquake forces rarely affect one-story buildings if properly constructed. In the case of one-story buildings such as those that HFIR proposes, the placement of thick walls between the steel frames to consolidate the structure against earthquakes would obviate the need for bracings.

Another problem that still exists is the lack of knowledge of constructing with concrete, which is a problem for all methods that use concrete because the local masons are not educated for making a proper suitable mix. Although the HFIR's structural system does not need skilled masons/labours for the skeleton (i.e. posts and beams), the roofing system remains of a great potential risk during earthquakes if it is to be built by local masons. The problem is that while HFIR recommends flat concrete decking roofs for its proposed structure, locals normally use block-joist roofs, consisting of prefabricated reinforced concrete joists with hollow blocks on which 5-7 cm concrete is poured. This system is more affordable and cheaper than HFIR's proposed steel-deck concrete-slab. The main problem with a block-joist roof is the poor bond it makes with steel beams, to which it is connected by means of only a few welding points. Clearly, such a bond would break easily during strong earthquakes.

Overall, it can be said that the construction method and structure proposed by HFIR is earthquake-resistant to some extent, yet unnecessarily expensive, and employs a technique that is overly sophisticated for the local builders. This method, however, would not resist long enough in earthquake if not properly supervised by an educated inspector of some kind in the roofing stage.

As for other proposed building methods, all the pros and cons enumerated for the HFIR method hold true for the methods employing HFIR's structure. In addition, drywall is a very expensive construction material in Iran. Wholly prefab systems are expensive and too sophisticated to be successfully adopted by the locals, resulting in an unsustainable reconstruction program. The proposals that use corrugated steel sheets for roofing do not pay any attention to the climatic and vernacular aspects of the local context. As is usually the case with almost all of top-down reconstruction programs, such methods lack "sensitivity in the urban and landscape design," and are practically incapable of yielding long-term solutions for the housing market (Lizarralde, 2001b). The only promising approach is that of Peace-Winds, which focuses on educating local masons and improving local know-how.

Gonzalo Lizarralde and Colin Davidson highlight the major defects of top-down (imported technology-based) approaches: "the use of designs that are too far from traditional typologies and indigenous distribution of spaces, the use of materials foreign to the local building practices and extremely high costs of logistics and transportation of materials" (Lizarralde, 2001b). A close look at the building practices in Bam before the earthquake attests to the fact that technology itself cannot solve the problem of making better earthquake-resistant houses; rather, it is necessary that the construction knowledge of the locals is improved.

CONCLUSION

There are a number of proposals for reconstructing houses in the city of Bam, all of which consider the earthquake-resistance of the building in one way or another. However, the lack of construction knowledge among the local masons seems to be the main obstacle to the implementation of these sophisticated methods in Bam. Moreover, the closed nature of the reconstruction program, along with the inflexible design of housing units, fails to address the needs of the inhabitants for adapting their homes to their individual desires or making changes or extensions in the future if needed.
In conclusion, the reconstruction program in Bam fails to address some essential features needed for a project of this nature to be successful and sustainable. These flaws can be rectified by adhering to the following recommendations:

1. The program must be balanced in such a way that it "meets a variety of related needs" such as providing "training in improved construction techniques, job opportunities for local builders and craftsmen" and so forth. All the

reconstruction methods proposed in Bam, with the exception of Peace-Winds' program, simply offer earthquake-resistant "replacement" units for the destroyed houses as their ultimate goal, which does not lead to the construction of a sustainable environment and city (Cuny et al., 1983).

2. The reconstruction should "involve fully the local people" and resources. The reconstruction program has thus far underestimated the importance of local community participation. The majority of materials, supplies, labourers, and expertise have been imported to the city for the reconstruction project, which definitely reduces the likelihood of the program succeeding (Cuny et al., 1983).

3. Similarly, solutions should be developed by employing local capabilities rather than importing sophisticated methods. Earthquake-resistant construction techniques imported to the city immediately after the earthquake are unlikely to be adopted by the locals, due to their unfamiliarity with them. In order for a reconstruction program to be sustainable, it must provide construction techniques that are easy to be learnt be the local builders/masons so that they can adopt it to their knowledge.

4. The future needs of inhabitants must be taken into consideration. Many families will be adding an extension to their new houses. Since the locals, including masons and labourers, are not fully involved in the reconstruction process, and since the majority of construction techniques employed in the reconstruction are fairly sophisticated for the locals, extending houses will be a great challenge for citizens in near future.

Based on the experience and knowledge gained from previous post-disaster reconstruction projects, it seems apparent that the Bam Reconstruction Program will fail to achieve its expected objectives due to the complexity and lack of flexibility in housing designs, the underestimation of local resources, and ignorance of the future needs of the inhabitants. However, future research will fully reveal the outcome of this reconstruction program and its long-term influence on housing and building practices in Bam.

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